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Ken Moody is changing the periodic table

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1969, in the middle of the Cold War, young Ken Moody sat in high school chemistry class memorizing the periodic table. At that time, there were 104 elements, and no one thought there were anymore to be found. Element discovery was a competitive business, Soviet and American teams competed to see who could create new elements first, but both teams thought they had reached the limit of what elements they could create.

Today, over 40 years later, Moody is adding new elements to the periodic table once thought to end at 104. He works with large international teams, praising his colleagues in Russia and thanking them for their help, as opposed to competing against them. Together the team has found six new elements, making the periodic table now unofficially end at 118, but Moody thinks it can go even farther.

Each of the new elements help us understand the forces that hold nuclei together, advancing our understanding of how the periodic table works. These elements don't last long; they are gone before Moody realizes they were created. Moody is searching for the Island of Stability, a theorized place on the periodic table where elements will be stable and last long enough for chemical tests. Element 114 is a special element, having 114 protons, like Element 114 would have, was predicted to be very stable. It falls beneath lead (Element 82) on the Periodic Table, which is the heaviest stable element. So 114 was thought to be in the middle of this Island of Stability, an element people had been trying to reach for many years. When Moody created it, he finally fulfilled the dreams of his prior mentors. periodic table

Heavy element science was an unexpected choice for Moody. In 1977 he went to UC-Berkeley to pursue a Ph.D. in chemistry, but none of the physical chemistry professors inspired him.

On a whim, he called Glenn Seaborg, a well-known physicist and one of the winners of the 1951 Nobel Prize in Physics for his co-discovery of Plutonium (element 94). Seaborg was working on transuranium elements, a group of elements that, except for very rare isotopes, do not exist in nature or the atoms that were present at earth's formation are now gone because of nuclear decay. They are the super heavy and highly radioactive elements larger than Uranium (element 92), located on a special region now standard on the periodic tables students memorize today. Element 106 is named in his honor, Seborgium. At the time, Seaborg was eager to help the next generation of scientists discover new elements.

“He dropped everything, spent two hours with me, walked me all over the Lawrence Berkeley National Laboratory, showed me the accelerators. And, at that point, I was completely hooked. As a salesman Glenn was an amazing man,” says Moody about his old mentor.

In 1985 Moody was hired by Ken Hulet of the **Lawrence Livermore National Laboratory** to bring new innovations to the discovery of new elements.

Moody and Hulet quickly got to work on finding the Island of Stability but didn’t have the where-with-all to do the experiments. “We knew they required long beam times, a lot of effort, there were only six of us in the group. I mean really, man power wise, facility wise; there was really no way we could compete here on our own.” So Hulet contacted the Russians and offered to cooperate with them, supplying them with things like the improved detector technologies they still use and radioactive material to use as targets in the experiments.

Today Moody and his partners in Dubna are still searching for the Island of Stability that intrigued both Hulet and Seaborg. The last element to exist in nature is Uranium (element 92). But, the bigger elements get, the shorter half-life they have. Slamming existing atoms together creates new elements, a process requiring lots of luck that the nuclei will fuse and form a new element. But these new creations go through alpha decay and fission before scientists realized they were created. All that remains are computer records.

The idea of creating stable elements is tempting. We already use synthetic elements for a number of things, Americium (element 95) is in smoke detectors, and other synthetic elements are used in medicine. Creating an even heavier element that is stable could lead to the “Teflon” of heavy element science, hopes Moody.

In 1999 Moody and the Livermore-Dubna team finally produced element 114, and one of its isotopes existed for several seconds, far longer than its periodic neighbors. But this isn’t long enough to prove the existence of the Island of Stability. Some theorists now think it could exist farther out, at element 120 or 122. Moody still thinks 114 is on the Island, at least its shores, we just don’t have the technology to create the stable isotope.

“There are actually two things that produce the extra stability,” he says. “There’s the proton number, to define the element, so an element with 114 protons is extra stable. But there is also a neutron number that we have not achieved.” But, admits Moody, this is the challenge for the next generation of chemists, as we don’t have the technology to do that yet.

Moody wants to see what happens to the periodic table, as elements get bigger. He wants to test the limits of periodicity and see if these heavy elements would be metals like lead or act like noble gases as some theorize.

“As the nucleus gets heavier and heavier, the electrons that actually are near the nucleus have to move faster and faster and they become relativistic. The mass of the electron, because it’s moving so fast, actually begins to increase. This makes the orbit shrink, the electron spends more time in the vicinity or actually inside the nucleus, this ripples out through the atom and changes

the configuration of the outer electrons. So there is some law that at some point periodicity, the periodic table, is going to fail."

Studying what happens to these large elements will be the next challenge for the young physicists and chemists Moody mentors, just as he continues to search for the answers to the questions that stumped his own mentors decades ago.